The effect of contrast on velocity encoding in Macaque area MT

Najib J. Majaj[1], Alan A. Stocker[12], Chris Tailby[1], J. Anthony Movshon, and Eero P. Simoncelli[12]

[1]Center for Neural Science, NYU and [2]Howard Hughes Medical Institute

When two patterns moving at the same speed are presented simultaneously, the lower contrast one appears to move slower [1]. This effect of contrast on perceived speed has proven to be a challenge for physiological and theoretical models of motion perception. MT is often implicated in mediating motion perception, yet the effect of contrast on the speed tuning of neurons in MT is inconsistent across studies, perhaps because of differences in experimental preparations and stimuli. Studies using single sinusoidal gratings show no effect of contrast on the temporal frequency tuning of MT neurons over a limited range of test contrasts [2]. On the other hand, studies using moving dots show a robust effect of contrast on velocity tuning; the preferred speed of MT neurons shifts to lower speeds at lower contrast [3,4].

With the goal of arriving at a population model that would link the physiology with the psychophysics, we measured the effect of contrast on velocity tuning in anaesthetized macaque area MT. We chose broadband gratings, consisting of three sinusoidal gratings of fixed spatial frequency (0.5 c/deg, 1 c/deg, 2 c/deg) summed with randomized phases, moving at 8 different speeds (over the range [3,60 deg/sec]),at three contrasts (5%, 20% and 80%) on a gray background. We presented the same set of stimuli to every cell, without optimizing for the spatial frequency or speed preferences.

Across the population of recorded neurons (n= 41), we find that reducing the contrast from 80% to 20% reduces the preferred velocity of the neuron by a factor of ~2.7. Although the measurements were noisier, reducing the contrast to 5% produced an even larger shift. This effect was more pronounced in cells that preferred high speeds at high contrast. By recording the same data set on every neuron without optimizing for the neuron's preference, and using the same stimuli used in a recent psychophysical study [5], our data set supports the formulation of a quantitative model linking the physiology with behavior.

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References

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